L Number	Hits	Search Text	DB	Time stamp
-	3	lambrecht-gregory.in.	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB	2004/01/27 15:01
-	52	("4430081" | "4580573" | "4626245" | "4857062" | "4895346" | "4929235" | "4978341" | "4978344" | "5000745" | "5006114" | "5041095" | "5051109" | "5092845" | "5092846" | "5098406" | "5102395" | "5106054" | "5114408" | "5125903" | "5127626" | "5154701" | "5167637" | "5176652" | "5195980" | "5205829" | "5207649" | "5215527" | "5215528" | "5256150" | "5267966" | "5269997" | "5273546" | "5290245" | "5290249" | "5300033" | "5304142" | "5304143" | "5304156" | "5312362" | "5312363" | "5330436" | "5334160" | "5336192" | "5350362" | "5350363" | "5356390" | "5366446" | "5403292" | "5458640" | "5584808" | "5591137" | "5599305").PN.	USPAT	2004/01/27 14:57
-	44	moore-robert.in.	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB	2004/01/27 15:03
-	18	banks-thomas.in.	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB	2004/01/27 15:09
-	1477915	(cannula or tube or tubular)same (rob or tube or advancer with curved adj tip with probe)	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB	2004/01/27 15:25
-	1477915	cannula or tube or tubular)same(rob or tube or advancer near3 curved adj tip with probe	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB	2004/01/27 15:14
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-	11	((606/79-80,84,61,45.ccls.)and(rod or tube with curve$ adj tip)and(probe) and spine) and (heat or ultrasound)	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB	2004/01/28 10:32

US-PAT-NO: 6179836

DOCUMENT-IDENTIFIER: US 6179836 B1

TITLE: Planar ablation **probe** for electrosurgical cutting and ablation

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Abstract Text - ABTX (1):

An electrosurgical ablation **probe** is provided having a shaft with a proximal end portion and a tongue-shaped distal end portion sized to fit within confined (e.g., narrow) spaces within the patient's body, such as the spaces around the articular cartilage between the femur and tibia and the spaces between adjacent vertebrae in the patient's **spine**. The **probe** includes at least one active electrode integral with or coupled to the tongue-shaped distal end portion and a connector on the proximal end portion for coupling the active electrode to an electrosurgical generator. The tongue-shaped distal end portion is substantially planar, and it offers a low profile, to allow access to confined spaces without risking iatrogenic injury to surrounding tissue, such as articular cartilage.

TITLE - TI (1):

Planar ablation **probe** for electrosurgical cutting and ablation

Brief Summary Text - BSTX (15):

The present invention provides a system and method for selectively applying electrical energy to structures within or on the surface of a patient's body. The system and method allow the surgical team to perform electrosurgical interventions, such as ablation and cutting of body structures, while limiting the depth of necrosis and limiting damage to tissue adjacent the treatment site. The system and method of the present invention are particularly useful for surgical procedures within accessible sites of the body that are suitable for electrode loop resection, such as the resection of prostate tissue and leiomyomas (fibroids) located within the uterus, and for procedures within confined (e.g., narrow) spaces within the patient's body, such as the spaces around the articular cartilage between the femur and tibia and the spaces between adjacent vertebrae in the patient's **spine**.

Brief Summary Text - BSTX (16):

The system according to the present invention comprises an electrosurgical **probe** having a shaft with a proximal end, a distal end, and at least one active electrode at or near the distal end. A connector is provided at the proximal end of the shaft for electrically coupling the active electrode to a high frequency voltage source. The active electrode includes at least one active

portion having a surface geometry configured to promote substantially high electric field intensities and associated current densities between the active portion and the target site when a high frequency voltage is applied to the electrodes. These high electric field intensities and current densities are sufficient to break down the tissue by processes including molecular dissociation or disintegration. The high frequency voltage imparts energy to the target site to ablate a thin layer of tissue without causing substantial tissue necrosis beyond the boundary of the thin layer of tissue ablated. This ablative process can be precisely controlled to effect the volumetric removal of tissue as thin as a few layers of cells with minimal heating of or damage to surrounding or underlying tissue structures.

Brief Summary Text - BSTX (20):

In a preferred embodiment, the system includes a return electrode spaced proximally from the active electrode. The return electrode may be integral with the shaft of the **probe,** or it may be separate from the shaft (e.g., on a liquid supply instrument). In an exemplary embodiment, the return electrode defines a liquid pathway for flow of electrically conducting liquid therethrough. The liquid is directed past the surface of the return electrode and over the active electrode to thereby provide a return current flow path between the target tissue site and the return electrode. A more complete description of methods and apparatus for generating a liquid current flow path between the active and returns electrodes can be found in application Ser. No. 08/485,219, filed on Jun. 7, 1995 (Attorney Docket 16238-000600), the complete disclosure of which has previously been incorporated herein by reference.

Brief Summary Text - BSTX (29):

In another representative embodiment, an electrosurgical ablation **probe** is provided having a shaft with a proximal end portion and a tongue-shaped distal end portion sized to fit within confined (e.g., narrow) spaces within the patient's body, such as the spaces around the articular cartilage between the femur and tibia and the spaces between adjacent vertebrae in the patient's **spine**. The **probe** includes at least one active electrode integral with or coupled to the tongue-shaped distal end portion and a connector on the proximal end portion for coupling the active electrode to an electrosurgical generator. The tongue-shaped distal end portion is substantially planar, and it offers a low profile to allow access to confined spaces without risking iatrogenic injury to surrounding tissue, such as articular cartilage. Usually, the distal end portion will have a combined height (i.e., including the active electrode(s)) of less than 2 mm and preferably less than 1 mm.

Brief Summary Text - BSTX (30):

In a specific configuration, the distal end portion of the **probe** has an active side and a substantially planar non-active side opposite the active side. The active electrode(s) are disposed on the active side, and are insulated from the non-active side to reduce undesirable current flow into tissue and surrounding electrically conducting fluids. In an exemplary embodiment, the non-active side of tongue-shaped end portion includes a substantially planar support member underlying and insulated from the active

electrode(s). The support member provides support for the cantilevered electrode(s), and it has a substantially smooth, atraumatic surface opposite the active electrode(s) to minimize damage to tissue.

Brief Summary Text - BSTX (31):

The active electrode(s) will usually be formed with edges, corners, surface asperities or the like to maximize the electric field intensities around the electrode surfaces. In a preferred configuration, the **probe** includes a plurality of active electrodes extending axially from the distal end of the shaft and having a semi-cylindrical cross-section formed by, for example, removing material from a-round or hollow tube. The electrodes are spaced from each other and supported by the underlying tongue-shaped support member. The edges formed by the semi-cylindrical cross-section will face away from the support member to form an active, high electric field intensity zone for ablation of tissue. In an exemplary embodiment, the electrodes are electrically isolated from each other and coupled to current-limiting elements or circuitry to limit current flow based on the impedance between the active electrode and the return or dispersive electrode.

Brief Summary Text - BSTX (32):

Similar to previous embodiments, the planar ablation **probe** will usually include a return electrode to facilitate operation in the bipolar mode. However, the **probe** can be utilized in the monopolar mode with a separate, dispersive electrode pad attached to the patient's skin, for example. In one configuration, the shaft of the **probe** comprises an electrically conducting material with an insulating layer covering the conducting material to protect surrounding tissue from electric current. The shaft includes an exposed portion spaced proximally from the active electrode(s) to generate a current return path therebetween.

Drawing Description Text - DRTX (22):

FIG. 23 illustrates a planar ablation **probe** for ablating tissue in confined spaces within a patient's body according to the present invention;

Drawing Description Text - DRTX (23):

FIG. 24 illustrates a distal portion of the planar ablation **probe** of FIG. 23;

Drawing Description Text - DRTX (24):

FIG. 25A is a front sectional view of the planar ablation **probe,** illustrating an array of semi-cylindrical active electrodes;

Drawing Description Text - DRTX (25):

FIG. 25B is a front sectional view of an alternative planar ablation **probe,** illustrating an array of active electrodes having opposite polarities;

Drawing Description Text - DRTX (26):
FIG. 26 is a top, partial section, view of the working end of the planar ablation **probe** of FIG. 23.

Drawing Description Text - DRTX (27):
FIG. 27 is a side cross-sectional view of the working end of the planar ablation **probe,** illustrating the electrical connection with one of the active electrodes of FIG. 26;

Drawing Description Text - DRTX (28):
FIG. 28 is a side cross-sectional view of the proximal end of the planar ablation **probe,** illustrating the electrical connection with a power source connector;

Drawing Description Text - DRTX (29):
FIG. 29 is a schematic view illustrating the ablation of meniscus tissue located close to articular cartilage between the tibia and femur of a patient with the ablation **probe** of FIG. 23;

Drawing Description Text - DRTX (30):
FIG. 30 is an enlarged view of the distal portion of the planar ablation **probe,** illustrating ablation or cutting of meniscus tissue;

Drawing Description Text - DRTX (31):
FIG. 31 illustrates a method of ablating tissue with a planar ablation **probe** incorporating a single active electrode;

Drawing Description Text - DRTX (32):
FIG. 32 is a schematic view illustrating the ablation of soft tissue from adjacent surfaces of the vertebrae with the planar ablation **probe** of the present invention;

Detailed Description Text - DETX (2):
The present invention provides a system and method for selectively applying electrical energy to a target location within or on a patient's body, such as solid tissue or the like, particularly including procedures within confined spaces such as the spaces around the articular cartilage between the femur and tibia and spaces between adjacent vertebrae in the patient's **spine,** and procedures that involve resection of relatively larger pieces of tissue. For convenience, the remaining disclosure will be directed specifically to the resection of prostate tissue, and the cutting, shaping or ablation of meniscal tissue located adjacent articular cartilage and soft tissue covering vertebrae. However, it will be appreciated that the system and method can be applied equally well to procedures involving other tissues of the body, as well as to

other procedures including open surgery, laparoscopic surgery, thoracoscopic surgery, and other endoscopic surgical procedures. Examples of such procedures include oral procedures, including gingival tissues and mucosal tissues located in the mouth or epidermal tissue on the outer skin, dermatological procedures, such as the treatment of tumors, abnormal tissues, and the like or, canalizing or boring channels or holes through tissue, such as the ventricular wall during transmyocardial revascularization procedures. Other procedures include laminectomy/disketomy procedures for treating herniated disks, decompressive laminectomy for stenosis in the lumbosacral and cervical **spine,** posterior lumbosacral and cervical **spine** fusions, treatment of scoliosis associated with vertebral disease, foraminotomies to remove the roof of the intervertebral foramina to relieve nerve root compression and anterior cervical and lumbar diskectomies. The present invention is also useful for resecting tissue within accessible sites of the body that are suitable for electrode loop resection, such as the resection of prostate tissue, leiomyomas (fibroids) located within the uterus and other diseased tissue within the body.

Detailed Description Text - DETX (4):

The electrosurgical **probe** will comprise a shaft having a proximal end and a distal end which supports one or more active electrode(s). The shaft may assume a wide variety of configurations, with the primary purpose being to mechanically support the active electrode(s) and permit the treating physician to manipulate the electrode(s) from a proximal end of the shaft. Usually, the shaft will be a narrow-diameter **rod** or tube, more usually having dimensions which permit it to be introduced into a body cavity, such as the arthroscopic cavity, through an associated trocar or cannula in a minimally invasive procedure, such as arthroscopic, laparoscopic, thoracoscopic, and other endoscopic procedures. Thus, the shaft will typically have a length of at least 5 cm for oral procedures and at least 10 cm, more typically being 20 cm, or longer for endoscopic procedures. The shaft will typically have a diameter of at least 1 mm and frequently in the range from 1 to 10 mm. In the case of open surgical procedures or procedures on the external portions of the patient's body (e.g., the skin), the shaft may have any suitable length and diameter that would facilitate handling by the surgeon.

Detailed Description Text - DETX (6):

The present invention may use a single active electrode or an electrode array distributed over a distal contact surface of a **probe**. In the case of an electrode array, the array usually includes (but is not limited to) a plurality of independently current-limited and/or power-controlled electrodes to apply electrical energy selectively to the target tissue while limiting the unwanted application of electrical energy to the surrounding tissue and environment resulting from power dissipation into surrounding electrically conductive liquids, such as blood, normal saline, and the like. The electrodes may be independently current-limited by isolating the electrodes from each other and connecting each electrodes to a separate power source that is isolated from the other electrode terminals. Alternatively, the electrodes may be connected to each other at either the proximal or distal ends of the **probe** to form a single wire that couples to a power source.

Detailed Description Text - DETX (7):

In an exemplary embodiment, each individual electrode in the electrode array is electrically insulated from all other electrodes in the array within said **probe** and is connected to a power source which is isolated from each of the other electrodes in the array or to circuitry which limits or interrupts current flow to the electrode when low resistivity material (e.g., blood or electrically conductive saline irrigant) causes a lower impedance path between the common electrode and the individual electrode terminal. The isolated power sources for each individual electrode may be separate power supply circuits having internal impedance characteristics which limit power to the associated electrode terminal when a low impedance return path is encountered, may be a single power source which is connected to each of the electrodes through independently actuatable switches or may be provided by independent current limiting elements, such as inductors, capacitors, resistors and/or combinations thereof. The current limiting elements may be provided in the **probe,** connectors, cable, controller or along the conductive path from the controller to the distal tip. Alternatively, the resistance and/or capacitance may occur on the surface of the active electrode(s) due to oxide layers which form selected electrode terminals (e.g., titanium or a resistive coating on the surface of metal). A more complete description of a system and method for selectively limiting current to an array of isolated electrode terminals can be found in commonly assigned, co-pending application Ser. No. 08/561,958, filed Nov. 22, 1996 (attorney docket No. 16238-000700), the complete disclosure of which has already been incorporated herein by reference.

Detailed Description Text - DETX (8):

It should be clearly understood that the invention is not limited to electrically isolated electrode terminals, or even to a plurality of electrode terminals. For example, the array of active electrode terminals may be connected to a single lead that extends through the **probe** shaft to a power source of high frequency current. Alternatively, the **probe** may incorporate a single electrode that extends directly through the **probe** shaft or is connected to a single lead that extends to the power source.

Detailed Description Text - DETX (15):

The method of the present invention comprises positioning an electrosurgical **probe** adjacent the target tissue so that at least one active electrode is brought into close proximity to the target site. A return electrode is positioned within an electrically conducting liquid, such as isotonic saline, to generate a current flow path between the target site and the return electrode. High frequency voltage is then applied between the active and return electrode through the current flow path created by the electrically conducting licuid in either a bipolar or monopolar manner. The **probe** may then be translated, reciprocated or otherwise manipulated to cut the tissue or effect the desired depth of ablation.

Detailed Description Text - DETX (16):

The current flow path may be generated by submerging the tissue site in an

electrical conducting fluid (e.g., arthroscopic surgery and the like) or by directing an electrically conducting liquid along a fluid path past the return electrode and to the target site to generate the current flow path between the target site and the return electrode. This latter method is particularly effective in a dry environment (i.e., the tissue is not submerged in fluid), such as open, endoscopic or oral surgery, because the electrically conducting liquid provides a suitable current flow path from the target site to the return electrode. A more complete description of an exemplary method of directing electrically conducting fluid between the active and return electrodes is described in Ser. No. 08/485,219, filed Jun. 7, 1995 (docket no. 16238-000600), previously incorporated herein by reference. The active electrode(s) are preferably disposed at the distal end of the **probe** and the return electrode is spaced from the active electrode and enclosed within an insulating sheath. This minimizes exposure of the return electrode to surrounding tissue and minimizes possible shorting of the current between the active and return electrodes. In endoscopic procedures, the **probe** will typically be passed through a conventional trocar cannula while viewing of the operative site is provided through the use of an endoscope disposed in a separate cannula.

Detailed Description Text - DETX (20):

The preferred power source of the present invention delivers a high frequency voltage selectable to generate average power levels ranging from tens of milliwatts to tens of watts up to hundreds of watts per electrode, depending on the number of electrodes, the target tissue being ablated, the rate of ablation desired or the maximum allowed temperature selected for the **probe** tip. The power source allows the user to select the voltage level according to the specific requirements of a particular oral surgery, dermatological procedure, open surgery or other endoscopic surgery procedure.

Detailed Description Text - DETX (23):

Yet another alternative involves the use of a power supply for energizing one or more electrodes having use of one or more channels of user-selectable voltage levels. The channels would incorporate an active control mechanism for limiting current levels below a preselected maximum level. The preselected maximum current level depends on the size and configuration of the electrode(s), and may be "factory" set or user selectable. Alternatively, an indicator device may be included in the **probe** (e.g., a resistor having a resistance value which corresponds to the maximum current level appropriate to a specific electrode configuration) such that the power supply can (1) first measure the indicator device value (e.g., measure the resistance of the indicator) contained within the **probe**; and (2) then set the maximum current level which corresponds to that resistance value. In this manner, a range of **probe** designs having greatly differing electrode size(s) and configuration(s) can be energized since the power supply will automatically adjust the maximum current level to correspond to each particular electrode size and configuration.

Detailed Description Text - DETX (25):

During the surgical procedure, the distal end of the **probe** or the active electrode(s) will usually be maintained at a small distance away from the target tissue surface. This small spacing allows for the continual resupply of electrically conducting liquid into the interface between the active electrode(s) and the target tissue surface. This continual resupply of the electrically conducting liquid helps to ensure that the thin vapor layer will remain between active electrode(s) and the tissue surface. In addition, dynamic movement of the active electrode(s) over the tissue site allows the electrically conducting liquid to cool the tissue surrounding recently ablated areas to minimize thermal damage to this surrounding tissue. Typically, the active electrode(s) will be about 0.02 to 2 mm from the target tissue and preferably about 0.05 to 0.5 mm during the ablation process. One method of maintaining this space is to translate and/or rotate the **probe** transversely relative to the tissue, i.e., a light brushing motion, to maintain a thin vaporized layer or region between the active electrode and the tissue. Of course, if coagulation of a deeper region of tissue is necessary (e.g., for sealing a bleeding vessel imbedded within the tissue), it may be desirable to press the active electrode(s) against the tissue to effect joulean heating therein.

Detailed Description Text - DETX (26):

In one embodiment of the invention, the active electrode or the electrode array will have an exposed length in the range from about 2.5 to 12.5 mm. With these electrode lengths, applicant has found that current-limiting inductors having values of about 0 to 100 uH, preferably about 25 to 50 uH, are suitable for establishing the requisite conditions for selective ablation described above (i.e., the generation of sufficient electric field intensities to form a vapor layer in the electrically conducting liquid and to induce the discharge of energy through the vapor layer to ablate tissue while minimizing substantial necrosis beyond several cell layers). Of course, the active electrode(s) may have a substantially smaller exposed length away from the **probe** than described above (on the order of about 0 to 0.5 mm). This configuration is described in Ser. No. 08/561,958 (attorney docket 16238-000700), the complete disclosure of which has already been incorporated herein by reference.

Detailed Description Text - DETX (28):

Power supply 28 has a selector 30 for varying the applied voltage level. Power supply 28 also includes a mechanism for energizing the active electrode of resectoscope 10 through the depression of a pedal 39 in a foot pedal 37 positioned close to the user. The foot pedal 37 will usually include a second pedal 38 for remotely adjusting the energy level applied to electrode 14. In an exemplary configuration, first pedal 37 will apply a higher voltage level suitable for cutting and ablating tissue and second pedal 38 will apply a lower voltage level suitable for coagulating and sealing tissue, such as a transected blood vessel (discussed in further detail below). A specific design of one power supply which may be used with the electrosurgical **probe** of the present invention is described in parent application PCT US 94/051168, the full disclosure of which has previously been incorporated herein by reference.

Detailed Description Text - DETX (32):

Return electrode oversheath 16 generally includes an electrically conducting, hollow shaft 86 coupled to a proximal housing 88 with a suitable epoxy adhesive, for example. The inner and outer surfaces of shaft 86 are covered with an electrically insulating layer 90 over the entire length of shaft 86 except for a distal end portion 92, which remains exposed to generate a current path from active loop assembly 12 (discussed below). Electrically insulating layer 90 may comprise a **heat** shrinkable tubing material, such as Kynar.TM., or it may be a deposited coating, such as Parylene.TM., polytetrafluoroethylene, polyimide, or the like. The provision of the electrically insulating layer 90 over return electrode shaft 86 prevents direct electrical contact between the return electrode and any adjacent body structure or the surgeon. Such direct electrical contact between a body structure (e.g., tendon) and an exposed return electrode member could result in unwanted heating and necrosis of the structure at the point of contact causing necrosis. If return electrode oversheath 16 is being used with an electrically insulating resectoscope sheath (e.g., a plastic tubular sheath), the inner surface of shaft 86 may remain exposed (i.e., no electrically insulating layer 90).

Detailed Description Text - DETX (38):

As shown in FIGS. 8 and 10A, loop electrode 194 comprises an elongate loop body 196 having first and second ends 198, 199 coupled to and extending within tubular members 192. Resecting loop electrode 194 is preferably composed of a corrosion resistant, electrically conductive metal or alloy, such as platinum, titanium, tantalum, tungsten, stainless steel, nickel and cobalt-based alloys and the like. It should be understood that loop electrode 194 may have configurations other than that described above and shown in FIGS. 8-11. Preferred requirements for electrode 194 are that: (1) the electrode fits within the available space within the working end of a resectoscope, which generally includes fiber optic or "glass **rod**" optical viewing and lighting means, articulating resecting means and irrigant supply ports; (2) the electrode is shaped and sized to allow the surgeon to view the tissue site; and (3) the electrode is configured to cut chips or small portions of tissue from the target site. Thus, the "loop" electrode may have a variety of shapes, such as semi-circular, square, triangular, rectangular, or multi-sided geometry (see FIGS. 10B-10D, for example). However, the semi-circular loop electrode of FIG. 10A is preferred because it easily fits within the cylindrical bore of conventional resectoscopes. In addition, this shape tends to facilitate good visibility for the surgeon, and it produces rapid resection of tissue.

Detailed Description Text - DETX (54):

Referring to FIGS. 23-32, preferred systems and methods for ablating tissue in confined (e.g., narrow) body spaces will now be described. FIG. 23 illustrates an exemplary planar ablation **probe** 400 according to the present invention. Similar to the resectoscope described above, **probe** 400 can be incorporated into electrosurgical system 11 (or other suitable systems) for operation in either the bipolar or monopolar modalities. **Probe** 400 generally includes a support member 402, a distal working end 404 attached to the distal end of support member 402 and a proximal handle 408 attached to the proximal end of support member 402. As shown in FIG. 23, handle 406 includes a

handpiece 408 and a power source connector 410 removably coupled to handpiece 408 for electrically connecting working end 404 with power supply 28 through cable 34 (see FIG. 1).

Detailed Description Text - DETX (55):

In the embodiment shown in FIG. 23, planar ablation **probe** 400 is configured to operate in the bipolar modality. Accordingly, support member 402 functions as the return electrode and comprises an electrically conducting material, such as titanium, or alloys containing one or more of nickel, chromium, iron, cobalt, copper, aluminum, platinum, molybdenum, tungsten, tantalum or carbon. In the preferred embodiment, support member 402 is an austenitic stainless steel alloy, such as stainless steel Type 304 from MicroGroup, Inc., Medway, Mass. As shown in FIG. 23, support member 402 is substantially covered by an insulating layer 412 to prevent electric current from damaging surrounding tissue. An exposed portion 414 of support member 402 functions as the return electrode for **probe** 400. Exposed portion 414 is preferably spaced proximally from active electrodes 416 by a distance of about 1 to 20 mm.

Detailed Description Text - DETX (56):

Referring to FIGS. 24 and 25, planar ablation **probe** 400 further comprises a plurality of active electrodes 416 extending from an electrically insulating spacer 418 at the distal end of support member 402. Of course, it will be recognized that **probe** 400 may include a single electrode depending on the size of the target tissue to be treated and the accessibility of the treatment site (see FIG. 30, for example). Insulating spacer 418 is preferably bonded to support member 402 with a suitable epoxy adhesive 419 to form a mechanical bond and a fluid-tight seal. Electrodes 416 usually extend about 2.0 mm to 20 mm from spacer 418, and preferably less than 10 mm. A support tongue 420 extends from the distal end of support member 402 to support active electrodes 416. Support tongue 420 and active electrodes 416 have a substantially low profile to facilitate accessing narrow spaces within the patient's body, such as the spaces between adjacent vertebrae and between articular cartilage and the meniscus in the patient's knee. Accordingly, tongue 420 and electrodes 416 have a substantially planar profile, usually having a combined height He of less than 4.0 mm, preferably less than 2.0 mm and more preferably less than 1.0 mm (see FIG. 25). In the case of ablation of meniscus near articular cartilage, the height He of both the tongue 420 and electrodes 416 is preferably between about 0.5 to 1.5 mm. The width of electrodes 416 and support tongue 420 will usually be less than 10.0 mm and preferably between about 2.0 to 4.0 mm.

Detailed Description Text - DETX (57):

Support tongue 420 includes a "non-active" surface 422 opposing active electrodes 416 covered with an electrically insulating layer (not shown) to minimize undesirable current flow into adjacent tissue or fluids. Non-active surface 422 is preferably atraumatic, i.e., having a smooth planar surface with rounded comers, to minimize unwanted injury to tissue in contact therewith, such as articular cartilage, as the working end of **probe** 400 is introduced into a narrow, confined body space. Non-active surface 422 of tongue 420 help to

minimize iatrogenic injuries to tissue, such as articular cartilage, so that working end 404 of **probe** 400 can safely access confined spaces within the patient's body.

Detailed Description Text - DETX (61):

In an alternative embodiment, adjacent electrodes 416 may be connected to the opposite polarity of source 28 so that current flows between adjacent active electrodes 416 rather than between active electrodes 416 and return electrode 414. By way of example, FIG. 25B illustrates a distal portion of a planar ablation **probe** 400' in which electrodes 416a and 416c are at one voltage polarity (i.e., positive) and electrodes 416b and 416d are at the opposite voltage polarity (negative). When a high frequency voltage is applied between electrodes 416a, 416c and electrodes 416b, 416d in the presence of electrically conducting liquid, current flows between electrodes 416a, 416c and 416b, 416d as illustrated by current flux lines 522'. Similar to the above embodiments, the opposite surface 420 of working end 404' of **probe** 400' is generally atraumatic and electrically insulated from active electrodes 416a, 416b, 416c and 416d to minimize unwanted injury to tissue in contact therewith.

Detailed Description Text - DETX (63):

Referring to FIGS. 29-32, methods for ablating tissue structures with planar ablation **probe** 400 according to the present invention will now be described. In particular, exemplary methods for treating a diseased meniscus within the knee (FIGS. 29-31) and for removing soft tissue between adjacent vertebrae in the **spine** (FIG. 32) will be described. In both procedures, at least the working end 404 of planar ablation **probe** 400 is introduced to a treatment site either by minimally invasive techniques or open surgery. Electrically conducting liquid is delivered to the treatment site, and voltage is applied from power supply 28 between active electrodes 416 and return electrode 414. The voltage is preferably sufficient to generate electric field intensities near active electrodes that form a vapor layer in the electrically conducting liquid, and induce the discharge of energy from the vapor layer to ablate tissue at the treatment site, as described in detail above.

Detailed Description Text - DETX (64):

Referring to FIG. 29, working end 404 and at least the distal portion of support member 402 are introduced through a percutaneous penetration 500, such as a cannula, into the arthroscopic cavity 502. The insertion of **probe** 400 is usually guided by an arthroscope (not shown) which includes a light source and a video camera to allow the surgeon to selectively visualize a zone within the knee joint. To maintain a clear field of view and to facilitate the generation of a vapor layer, a transparent, electrically conductive irrigant 503, such as isotonic saline, is injected into the treatment site either through a liquid passage in support member 402 of **probe** 400, or through another instrument. Suitable methods for delivering irrigant to a treatment site are described in commonly assigned, co-pending application Ser. No. 08/485,219, filed on Jun. 7, 1995 (Attorney Docket 16238-000600), the complete disclosure of which has previously been incorporated herein by reference.

Detailed Description Text - DETX (65):

In the example shown in FIG. 29, the target tissue is a portion of the meniscus 506 adjacent to and in close proximity with the articular cartilage 510, 508 which normally covers the end surfaces of the tibia 512 and the femur 514, respectively. The articular cartilage 508, 510 is important to the normal functioning of joints, and once damaged, the body is generally not capable of regenerating this critical lining of the joints. Consequently, it is desirable that the surgeon exercise extreme care when treating the nearby meniscus 506 to avoid unwanted damage to the articular cartilage 508, 510. The confined spaces 513 between articular cartilage 508, 510 and meniscus 506 within the knee joint are relatively narrow, typically on the order of about 1.0 mm to 5.0 mm. Accordingly, the narrow, low profile working end 404 of ablation **probe** 400 is ideally suited for introduction into these confined spaces 513 to the treatment site. As mentioned previously, the substantially planar arrangement of electrodes 416 and support tongue 420 (typically having a combined height of about 0.5 to 1.5 mm) allows the surgeon to deliver working end 404 of **probe** 400 into the confined spaces 513, while minimizing contact with the articular cartilage 508, 510 (see FIG. 30).

Detailed Description Text - DETX (66):

As shown in FIG. 30, active electrodes 416 are disposed on one face of working end 404 of **probe** 400. Accordingly, a zone 520 of high electric field intensity is generated on each electrode 416 on one face of working end 404 while the opposite side 521 of working end 404 is atraumatic with respect to tissue. In addition, the opposite side 521 is insulated from electrodes 416 to minimize electric current from passing through this side 521 to the tissue (i.e., adjacent articular cartilage 508). As shown in FIG. 30, the bipolar arrangement of active electrodes 416 and return electrode 414 causes electric current to flow along flux lines 522 predominantly through the electrically conducting irrigant 503, which envelops the tissue and working end 404 of ablation **probe** 400 and provides an electrically conducting path between electrodes 416 and return electrode 414. As electrodes 416 are engaged with, or positioned in close proximity to, the target meniscus 506, the high electric field present at the electrode edges cause controlled ablation of the tissue by forming a vapor layer and inducing the discharge of energy therefrom. In addition, the motion of electrodes 416 relative to the meniscus 506 (as shown by vector 523) causes tissue to be removed in a controlled manner. The presence of the irrigant also serves to minimize the increase in the temperature of the meniscus during the ablation process because the irrigant generally comes in contact with the treated tissue shortly after one of the electrodes 416 has been translated across the surface of the tissue.

Detailed Description Text - DETX (67):

Referring now to FIG. 32, an exemplary method for removing soft tissue 540 from the surfaces of adjacent vertebrae 542, 544 in the **spine** will now be described. Removal of this soft tissue 540 is often necessary, for example, in surgical procedures for fusing or joining adjacent vertebrae together. Following the removal of tissue 540, the adjacent vertebrae 542, 544 are stabilized to allow for subsequent fusion together to form a single monolithic

vertebra. As shown, the low-profile of working end 404 of **probe** 400 (i.e., thickness values as low as 0.2 mm) allows access to and surface preparation of closely spaced vertebrae. In addition, the shaped electrodes 416 promote substantially high electric field intensities and associated current densities between active electrodes 416 and return electrode 414 to allow for the efficient removal of tissue attached to the surface of bone without significantly damaging the underlying bone. The "non-active" insulating side 521 of working end 404 also minimizes the generation of electric fields on this side 521 to reduce ablation of the adjacent vertebra 542.

Detailed Description Text - DETX (68):

The target tissue is generally not completely immersed in electrically conductive liquid during surgical procedures within the **spine,** such as the removal of soft tissue described above. Accordingly, electrically conducting liquid will preferably be delivered into the confined spaces 513 between adjacent vertebrae 542, 544 during this procedure. The fluid may be delivered through a liquid passage (not shown) within support member 402 of **probe** 400, or through another suitable liquid supply instrument.

Detailed Description Text - DETX (69):

Other modifications and variations can be made to disclose embodiments without departing from the subject invention as defined in the following claims. For example, it should be clearly understood that the planar ablation **probe** 400 described above may incorporate a single active electrode, rather than a plurality of such active electrodes as described above in the exemplary embodiment. FIG. 31 illustrates a portion of a planar ablation **probe** according to the present invention that incorporates a single active electrode 416' for generating high electric field densities 550 to ablate a target tissue 552. Electrode 416' may extend directly from a proximal support member, as depicted in FIG. 31, or it may be supported on an underlying support tongue (not shown) as described in the previous embodiment. As shown, the representative single active electrode 416' has a semi-cylindrical cross-section, similar to the electrodes 416 described above. However, the single electrode 416' may also incorporate any of the above described configurations (e.g., square or star shaped solid wire) or other specialized configurations depending on the function of the device.

Claims Text - CLTX (1):

1. An electrosurgical **probe** for applying electrical energy to a target site within a confined spaced in a patient's body, the instrument comprising:

Claims Text - CLTX (7):

2. The **probe** of claim 1 wherein the distal end portion of the shaft is configured for introduction into spaces between articular cartilage and the meniscus between the tibia and the femur to access meniscal tissue at the meniscus/tibial plateau interface.

Claims Text - CLTX (8):
3. The **probe** of claim 1 wherein the distal end portion of the shaft is configured for introduction into spaces between intervertebral disks in the **spine**.

Claims Text - CLTX (9):
4. The **probe** of claim 1 wherein the thickness of the distal end portion from the active side to the non-active side is less than 2 mm.

Claims Text - CLTX (10):
5. The **probe** of claim 1 wherein the thickness of the distal end portion from the active side to the non-active side is less than 1 mm.

Claims Text - CLTX (11):
6. An electrosurgical **probe** for applying electrical energy to a target site within a confined spaced in a patient's body, the instrument comprising:

Claims Text - CLTX (15):
7. The **probe** of claim 6 wherein the distal end portion includes a substantially planar support member underlying and insulated from the active electrode.

Claims Text - CLTX (16):
8. The **probe** of claim 7 wherein the support member has a substantially smooth, atraumatic surface opposite the active electrode to minimize damage to tissue.

Claims Text - CLTX (17):
9. The **probe** of claim 6 further comprising a return electrode positioned proximally to the active electrode for generating a current return path therebetween.

Claims Text - CLTX (18):
10. The **probe** of claim 9 wherein the return electrode is located on the shaft.

Claims Text - CLTX (19):
11. The **probe** of claim 6 wherein the active electrode comprises an elongate body having a distal active portion with a surface geometry configured to promote substantially high electric field intensities between the active portion and the target site when a high frequency voltage is applied to the electrode.

Claims Text - CLTX (20):
12. The **probe** of claim 11 wherein the active portion of the active electrode defines a semi-circular transverse cross-sectional shape with first and second ends and an inner slot therebetween, the first and second ends each having a pair of edges for promoting localized high electric field intensities near the edges.

Claims Text - CLTX (21):
13. The **probe** of claim 12 wherein the distal end portion of the shaft includes a support member and an insulating layer disposed between the support member and the active electrode, the first and second ends of the active portion facing away from the insulating layer.

Claims Text - CLTX (22):
14. The **probe** of claim 13 wherein the first and second ends of the active portion form a planar surface that is substantially parallel to the support member.

Claims Text - CLTX (23):
15. The **probe** of claim 11 wherein the active portion of the active electrode is positioned in close proximity to the target site in the presence of electrically conducting liquid, the surface geometry of the active portion configured to promote high electric field intensities sufficient to vaporize the electrically conducting liquid in a thin layer over at least a portion of the electrode surface and to induce the discharge of energy from the vapor layer.

Claims Text - CLTX (24):
16. The **probe** of claim 6 wherein the distal end portion of the shaft has a length less than about 10 mm and a width less than about 10 mm.

Claims Text - CLTX (25):
17. The **probe** of claim 6 further comprising an array of electrically isolated active electrodes, each having a semi-circular cross-section with first and second ends and an inner slot therebetween, the first and second ends each having a pair of edges for promoting localized high electric field intensities near the edges.

Claims Text - CLTX (26):
18. The **probe** of claim 17 wherein the active electrodes are spaced from each other by a distance of about 5 to 100 mils.

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606/45

US-PAT-NO: 6491690

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TITLE: Electrosurgical instrument

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Brief Summary Text - BSTX (5):

There are a number of variations to the basic design of the bipolar **probe**. For example, U.S. Pat. No. 4,706,667 describes one of the fundamentals of the design, namely that the ratio of the contact areas of the return electrode and of the active electrode is greater than 7:1 and smaller than 20:1 for cutting purposes. This range relates only to cutting electrode configurations. When a bipolar instrument is used for desiccation or coagulation, the ratio of the contact areas of the two electrodes may be reduced to approximately 1:1 to avoid differential electrical stresses occurring at the contact between the tissue and the electrode.

Brief Summary Text - BSTX (25):

Advantageously, the tissue treatment electrode is provided at the distal end of a **rod** mounted within, and movable relative to, the instrument shaft. Conveniently, the tissue treatment electrode is constituted by the distal end portion of the **rod**.

Brief Summary Text - BSTX (26):

In a preferred embodiment, the drive means is such as to reciprocate the **rod** within the channel. Advantageously, the drive means is constituted by a motor and coupling means for converting the rotary output of the motor into reciprocatory movement of the **rod**.

Brief Summary Text - BSTX (27):

In another preferred embodiment, the drive means is such as to rotate the **rod** within the channel. An electric motor may constitute the drive means.

Brief Summary Text - BSTX (34):

The electrosurgical instrument of the invention is useful for dissection, resection, vaporisation, desiccation and coagulation of tissue, as well as for combinations of these functions. It has a particular application in arthroscopic surgery as it pertains to endoscopic and percutaneous procedures performed on joints of the body including, but not limited to, such techniques as they apply to the **spine** and other non-synovial joints. Arthroscopic operative procedures may include: partial or complete meniscectomy of the knee joint including meniscal cystectomy; lateral retinacular release of the knee

joint; removal of anterior and posterior cruciate ligaments or remnants thereof; labral tear resection, acromioplasty, bursectomy and subacromial decompression of the shoulder joint; anterior release of the temperomandibular joint; synovectomy, cartilage debridement, chondroplasty, division of intra-articular adhesions, fracture and tendon debridement as applied to any of the synovial joints of the body; inducing thermal shrinkage of joint capsules as a treatment for recurrent dislocation, subluxation or repetitive stress injury to any articulated joint of the body; discectomy either in the treatment of a disc prolapse or as part of a spinal fusion via a posterior or anterior approach to the cervical, thoracic and lumbar **spine** or any other fibrous joint for similar purposes; excision of diseased tissue; and haemostasis.

Detailed Description Text - DETX (3):

FIG. 2 shows the first form of electrode unit E1 for detachable fastening to the electrosurgical instrument handpiece 3, the electrode unit comprising a shaft 10, which is constituted by a tube made of stainless steel. A tissue treatment (active) electrode 12 is provided at the distal end portion of the shaft 10. The active electrode 12 is provided by the distal end portion of a **rod** 14 made of tungsten, the active electrode extending at right angles to the **rod**. The **rod** 14 has a diameter of 0.4 to 0.6 mm. A ceramic tube 18 is fixed to the **rod** 14 immediately adjacent to the active electrode 12. A ceramic tip 20 is fixed within the out-turned distal end portion of the shaft 10.

Detailed Description Text - DETX (4):

As shown in FIG. 2, the active electrode 12 protrudes through a longitudinal slot 20a formed in the ceramic tip 20. That portion of the **rod** 14 not covered by the ceramic tube 18 is provided with an insulating sleeve 22 made of polyimide, polytetrafluoroethylene or by separate sleeves made by these two substances. A **heat** sleeve 24 made of polytetrafluoroethylene or polyimide, covers the adjoining regions of the ceramic tube 18 and the sleeve 22.

Detailed Description Text - DETX (5):

The major portion of the length of the shaft 10 is provided with an insulating **heat** shrink sleeve 26 made of polyvinylidenefluoride. The sleeve 26 does not cover the distal end portion of the shaft 10, that region of the shaft constituting a return electrode 28.

Detailed Description Text - DETX (6):

The **rod** 14 is mounted for reciprocal movement within the shaft 10, that end of the **rod** remote from the active electrode 12 being fixed to a coupling member 30 slidably mounted within one end 32a of a sleeve 32 made of stainless steel. The other end 32b of the sleeve 32 is fixed to the adjacent end portion of the shaft 10. A top hat washer 34 is located within the sleeve end 32b, the washer constituting a backing member for a silicone gland 36 and a delrin bush 38. A return spring 40 acts between the bush 38 and the coupling member 30. The **rod** 14 passes through apertures in the washer 34, the gland 36 and the bush 38.

Detailed Description Text - DETX (7):
An off-set shaft 30a is fixed to the end face of the coupling member 30, the free end of this shaft being engageable with an inclined end face 42a of a rotatable coupling member 42 fixed to the rotary output shaft of a motor 44. Hence, rotation of the output shaft of the motor 44 results in reciprocation of the coupling member 30 and the **rod** 14.

Detailed Description Text - DETX (8):
The hollow interior of the shaft 10 is connected to a transverse tubular member 10a which is connected to a suction pump (not shown), and so constitutes a suction/exhaust port. As shown in FIG. 2, the active electrode 12 is positioned at the end of an aspiration channel constituted by the annular cavity defined by the interior of the shaft 10 and the **rod** 14, so that vapour bubbles and/or particulate material which, in use, are formed in the region of the active electrode, can be aspirated from the region for removal via the slot 20a, the aspiration channel and the port 10a.

Detailed Description Text - DETX (16):
In use, when the generator 1 is turned on, the motor 44 begins to rotate, causing the **rod** 14 to oscillate with an amplitude of 0.5 mm. The oscillation of the **rod** 14 within the shaft 10 provides a mechanical agitation within the shaft that is sufficient to dislodge any sublimation products which condense within the shaft. In this way, blockage of the shaft 10 is prevented, so that the instrument can be used on a continuous basis.

Detailed Description Text - DETX (23):
Because of its speed of debulking and side-effect configuration, the electrode unit E1 also has advantages in urological surgery as an EVAP technique for use in conjunction with a resectoscope. A resectoscope electrode unit is introduced very differently, in that is mounted on an endoscope prior to passage of the assembled instrument through a working sheath via the urethra. The proximal end of the electrode unit is connected to a trigger assembly and an electrical contact which is integral with the resectoscope. By this means, the electrode unit E1 can be moved back and forth through a defined range of motion by operating the trigger mechanism. As the electrode unit E1 is assembled prior to introduction, the size of the tip is not constrained by working channel dimensions, but rather by the diameter of the working sheath which can be up to 10 mm. Part of this diameter is occupied by the support wires to the electrode unit E1, which wires are commonly bent in a downward angle, with respect to the endoscopic image, to the working tip, so that they do not interfere with either visulation or its operation. Because of the reciprocatory movement of the **rod** 14, the active electrode 12 operates over a length lying within the range of from 3 mm to 4 mm and a width lying in the range of from 2 mm to 3 mm, and this size is necessary for urological surgery given that, on average, 20-30 grammes of prostate tissue must be removed.

Detailed Description Text - DETX (31):
FIGS. 5 and 6 show the second form of electrode unit E2. This instrument is

a modification of that shown in FIGS. 2 and 3, and so like reference numerals will be used for like parts, and only the modifications will be described in detail. There are two main modifications, the first being to the drive to the **rod** 14, and the second to the configuration of the active electrode 12.

Detailed Description Text - DETX (32):

In the first modification, the motor 44 rotatably drives the **rod** 14 via a coupling assembly 42. As with the embodiment of FIGS. 2 and 3, the **rod** 14 passes through aligned apertures in the washer 34, the gland 36 and the delrin bush 38. The bush 38 is somewhat longer than the equivalent bush of the embodiment of FIGS. 2 and 3 extending to the end 32a of the sleeve 32. A slip ring 46a is provided to connect the connector 46 to the **rod** 14.

Detailed Description Text - DETX (33):

The other main modification is that the active electrode 12 (the free end of the tungsten **rod** 14--in this embodiment of 0.5 mm diameter) is bent back over the free end of the ceramic tube 18. The tumed-back portion 12a of the electrode 12 constitutes a side effect electrode. An apertured region 20a is formed between the ceramic tip 20 and the active electrode 12, this region loading to the aspiration channel defined by the interior of the shaft 10.

Detailed Description Text - DETX (34):

Another modification is that the **rod** 14 is a flexible drive **rod** whose distal end portion is off-set with respect to the central longitudinal axis of the shaft 10. In use, when the generator 1 is turned on, the motor 44 begins to rotate, causing the **rod** 14 to rotate within the shaft 10. This rotation provides a mechanical agitation that is sufficient to dislodge any sublimation products which condense within the shaft. The off-set of the **rod** 14 results in an unstable oscillation being set up in the **rod,** which sweeps adherent tissue debris from the inner wall of the shaft 10.

Detailed Description Text - DETX (36):

FIGS. 9 and 10 show the fourth form of electrode unit E4. This unit E4 is also a modification of the unit E2, so like reference numerals will be used for like parts, and only the modifications will be described in detail. Here, the main modification is to the configuration of the active electrode 12 which, in this case, is an end effect electrode, being constituted by a simple hook-shaped end portion 12a at the end of the **rod** 14. As with the embodiments of FIGS. 5 and 6, the **rod** 14 is a flexible drive **rod** whose distal end portion off-set with respect to the central longitudinal axis of the shaft 10.

Detailed Description Text - DETX (41):

The relative contributions of tissue incision or morcellation and tissue vaporisation to the overall tissue debunking process can be controlled by the interaction of the bore of the terminal aspiration channel, the suction pressure and the bulk of the active electrode 12. Owing to the overall size constraints on the external diameter of the instrument it is, in general, the

diameter of the drive **rod** 14 whose distal tip forms the active electrode 12 and which, therefore, also provides the means of electrical connection to the active electrode, which determines whether tissue removal occurs primarily by incision/morcellation or vaporisation. Typically a drive **rod** 14 (and hence active electrode 12) formed from 0.2-1.0 mm diameter tungsten wire provides incision/morcellation, and a drive **rod** active electrode formed from 0.5 mm diameter tungsten wire primarily provides vaporisation. The incision/morcellation technique has advantages when dealing with soft friable tissue, whereas the vaporisation technique has advantages when application is made to dense fibrous or cartilaginous tissue. The design can, therefore, be optimised for the type of tissue encountered during use in particular surgical specialities or, alternatively, a multi functional design with a drive **rod** and active electrode typically formed from 0.4-0.6 mm tungsten can be used.

Detailed Description Text - DETX (42):

For all four electrode units E1 to E4, agitation within the aspiration shaft 10 significantly reduces the risk of blockage, either by morcellated tissue, sublimated products of vaporisation or both. This can be accomplished by axial or rotary motion of the **rod** 14 which is positioned within the aspiration channel, with or without other means of fluid agitation, including the cycling of suction pressure, which may be provided as an integral feature of generator output, control of suction, and sonic pressure waves. To enhance the effect of agitation, it is beneficial to construct the drive **rod** 14 from a lubricious material to reduce adherence.

Detailed Description Text - DETX (46):

It will be apparent that modifications could be made to the electrode units described above. For example, instead of providing an off-set drive **rod** 14, this **rod** could be loosely coiled so that the coils lie against the inner wall of the aspiration channel, whereby, during rotation, a worm screw action occurs to encourage proximal movement of tissue debris, as well as cleaning of the inner wall of the channel.

Detailed Description Text - DETX (48):

It would also be possible to introduce axial motion during rotation. Thus, for the electrode unit E4, the simple 90.degree. hook form active electrode 12 can rotate on a bearing surface provided by the distal end face of the ceramic tube 18, this end face being provided with ratchet teeth features. Thus, as the **rod** 14 rotates, the hook-shaped end portion 12a moves in and out as it engages and disengages the ratchet teeth, this axial movement being permitted by the off-set flexible drive **rod** 14 repeatedly elongating and shortening.

Detailed Description Text - DETX (52):

With the rotary action electrode units E2 to E4, the effective size of the active electrode 12 is increased, and a significant aspect is the incision of tissue. The active electrode 12 is fabricated from the distal end of the drive **rod** 14, so simple wire form electrodes meet these performance requirements. The only drawback of these simple electrode forms is that asymmetry of the

tissue contact can make it difficult to maintain an accurate location on a tissue surface, particularly when that surface is comprised of more fibrous or more dense tissue.

Detailed Description Text - DETX (53):

If the wire form active electrode 12 protrudes from the ceramic tube 18, for example in a simple loop form as with the electrode unit E2, then the potential exists for the loop to excise tissue pieces too large for aspiration through the distal opening of the aspiration channel. Should this occur, the exposed distal end of the drive **rod** 14 within the aspiration channel performs an important function in morcellating and vaporising such tissue pieces, so that they are reduced in size sufficiently to enter the aspiration channel. This function is enhanced by the eccentric motion of the drive **rod** 14 within the aspiration channel.

Detailed Description Text - DETX (59):

In summary the electrosurgical instrument of the invention has the following advantageous features 1. A small active electrode surface which is able to treat large tissue areas by virtue of active electrode movement. 2. A small active electrode to enable vaporisation, despite the cooling effects created by aspiration. 3. A mechanical movement at the active electrode tip, compatible with material removal within the aspiration channel. 4. Aspiration operation is dependent upon the vaporisation condition. 5. At least the outside of the shaft 10 is coated with a non-stick material such as polytetrafluoroethylene--ideally the inside of the shaft as well. 6. Active electrode tip movement occurs across the face of the aspiration channel, so that any lodged tissue is electrosurgically morcellated. 7. Active electrode agitation is dependent upon the vaporisation condition. 8. Discontinuities within the agitator **rod** ensure that the internal surfaces of the shaft are cleaned; or the **rod** flexes sufficiently to create the same effect. 9. A ceramic-to-ceramic interface at the active electrode tip ensures that the internal circumference of the outer ceramic is wiped by the inner ceramic. 10. The agitator **rod** is independently insulated in ceramic at its tip. 11. Offset rotary action for a side-effect electrode to enable flat surface engagement.

Claims Text - CLTX (3):

3. An electrosurgical instrument as claimed in claim 2, wherein the tissue treatment electrode is provided at the distal end of a **rod** mounted within, and movable relative to, the instrument shaft.

Claims Text - CLTX (4):

4. An electrosurgical instrument as claimed in claim 3, wherein the tissue treatment electrode is constituted by the distal end portion of the **rod**.

Claims Text - CLTX (5):

5. An electrosurgical instrument as claimed in claim 3, wherein drive means is such as to reciprocate the **rod** within the channel.

Claims Text - CLTX (6):
6. An electrosurgical instrument as claimed in claim 5, wherein the drive means is constituted by a motor and coupling means for converting the rotary output of the motor into reciprocatory movement of the **rod**.

Claims Text - CLTX (7):
7. An electrosurgical instrument in claim 3, wherein the drive means is such as to rotate the **rod** within a channel formed within the instrument shaft for removing matter from a region surrounding the tissue treatment electrode.

Claims Text - CLTX (28):
28. An electrosurgical instrument for the treatment of tissue in the presence of an electrically-conductive fluid medium, the instrument comprising: an instrument shaft, a tissue treatment electrode provided at the distal end of a **rod** mounted within the instrument shaft for electrosurgically excising tissue pieces at an operation site, a drive means constituted by, a motor and coupling means for converting the rotary output of the motor into reciprocatory movement of the **rod,** the tissue treatment electrode being movable cyclically so as to be reciprocatable relative to the distal end of the shaft, and vaporisation control means for controlling the power threshold for vaporisation of the electrically-conductive medium at the tissue treatment electrode.

Claims Text - CLTX (30):
30. An electrosurgical instrument as claimed in claim 29 wherein the tissue treatment electrode is mounted at the distal end of a **rod** mounted within, and movable relative to, the instrument shaft.

Claims Text - CLTX (31):
31. An electrosurgical instrument as claimed in claim 30 further comprising a drive for reciprocating the **rod** within the instrument shaft, whereby the tissue treatment electrode is reciprocated relative to the distal end of the shaft.

Claims Text - CLTX (32):
32. An electrosurgical instrument as claimed in claim 31 wherein the **rod** is formed with a portion off-set from the longitudinal axis of the instrument shaft.

Current US Cross Reference Classification - CCXR (2):
606/45